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SUBSURFACE SOILS INVESTIGATION
No. 2 FUEL OIL SPILL
SCOTT PAPER COMPANY
CHESTER, PENNSYLVANIA, FACILITY

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1.0 INTRODUCTION AND BACKGROUND INFORMATION

This subsurface soils investigation was conducted at the request of Scott Paper Company for their Chester, Pennsylvania Facility. A map showing the location of this facility is included as Figure 1.

Scott Paper Company discovered a minor leak from the discharge line of a #2 fuel oil storage tank in February, 1989 (Figure 4). The leak originated upstream of the valve from a corroded portion of the discharge line. Upon their discovery, Scott Paper Company personnel immediately responded by pumping down the tank in order to greatly reduce or stop the leak. The duration of the pump-down was approximately 10 to 12 hours.

The spillage breached the containment berm and entered a gravel dry well installed in the underlying sediments in this area. After entering this dry well, it is believed that the oil then migrated along a storm sewer trench which discharges to a cove adjacent to the Delaware River (See Figure 2). Absorbent booms were set across the cove to mitigate the movement of oil to the Delaware River. Scott Paper Company then flushed the storm drain with water to remove any accumulated oil. No oil has been observed discharging from the storm sewer since the line was flushed. Reportedly, approximately 100 to 200 gallons of oil from the spill was recovered by Scott Paper Company during the activities described above. The quantity of total spillage is unknown. Scott Paper Company's method of oil containment and recovery has been monitored and approved by the U. S. National Coast Guard.

Scott Paper Company personnel have subsequently observed that, during low tide or following rain, small quantities of oil enter the Delaware River through bulkheads forming the cove. Although oil from the spill had been controlled from entering the cove of the Delaware River and a major portion of the oil had apparently

been remediated, there was some evidence of oil contamination in this area. The absorbent booms are still maintained to recover any residual oil which may enter the cove.

Scott Paper Company contracted Triegel & Associates, Inc. (TAI) to perform a subsurface soils investigation in order to: (1) define the extent of contaminated subsurface materials; (2) determine magnitudes of contamination; and (3) install any necessary monitoring wells to monitor ground water quality at the site. The wells may also be used for product recovery, if necessary.

2.0 METHODS

The objectives of the field investigation were to delineate the extent of subsurface contamination by No.2 fuel oil and implement appropriate monitoring/mitigation measures, if necessary. The following tasks were proposed to carry out these objectives: describe split spoon samples in detail, note any visible oil contamination, perform field testing for the presence of volatile organic compounds, collect samples for laboratory analyses, and select the location(s) for any necessary ground water monitoring/recovery well(s).

The site investigation was conducted on October 3, 1989, and consisted of drilling six test borings, designated TB-1 through TB-6. The test borings were drilled to depths ranging from 10 to 16 feet utilizing continuous flight, hollow-stem auger drilling techniques. Test boring locations were selected based on the details of the spill incident reported by Scott Paper Company and subsequent observations made during the investigation conducted by TAI personnel.

An attempt was made to continuously sample soils with a standard, driven, split-spoon sampler, in accordance with ASTM D-1586. A sample was obtained for every 2 feet of penetration and jarred for

field organic vapor screening. Each hole was logged in detail (see Appendix 1) and any visible oil contamination noted. Soil samples were selected to be retained for laboratory analyses based on the results of the organic vapor screening and visual descriptions. The vapor screening was accomplished in the field with a portable OVA/GC (Organic Vapor Analyzer/Gas Chromatograph). The OVA/GC analyses used jarred, sealed soil samples and were performed on the head-space (air portion of the jar).

Since fuel oil is immiscible in water and is of a lower specific gravity than water, it will tend to form a layer on top of the ground water surface. Because of this fact, soil samples were collected at or near the top of the water table from each boring for laboratory testing for total petroleum hydrocarbon compounds (EPA Method 418). Sample selection for laboratory analyses was also based on visual observations of oils within the soil samples.

These analyses were performed to aid in the delineation of the petroleum hydrocarbon contamination and to provide quantitative data on the concentration of hydrocarbons in the soils.

3.0 RESULTS OF THE INVESTIGATION

3.1 SUBSURFACE SOILS INVESTIGATION

3.1.1 Nature of the Deposits

Based on discussions with Scott Paper personnel, it was reported that the cove shown on Figure 2 once extended farther west, beyond the locations of test borings TB-3 and TB-6. A portion of the cove was backfilled to its present position, at some unknown time, with material similar to that which was encountered in test borings TB-3 and TB-6. Cross-section A-A' (Figure 4) illustrates the site's general stratigraphy as indicated by the field investigation and

reports of prior site development. The location of the transect for cross-section A-A' is shown on Figure 3.

Test borings TB-1 and TB-2, located in the eastern portion of the study area, encountered approximately 8 feet of loose fill (clayey silt with rock, brick, and coal fragments) above dark gray, naturally occurring silt. The silt contains thin layers of vegetal matter, parallel to thin bedding laminations.

In the north-central portion of the area under investigation, TB-3 and TB-6 encountered fill (silt/clay with rock and brick fragments) throughout their depths.

To the west, TB-4 and TB-5 encountered approximately 8 feet of fill above wood and oyster shell debris. Large voids were encountered in the wood and oyster shell debris at these locations.

3.1.2 Results of Field Organic Vapor Screening

As was mentioned earlier in the text, a representative portion of each two-foot drive sample was placed in a sealed glass jar for organic vapor screening using an OVA/GC. Total organic vapor concentrations were recorded and are tabulated on the Field OVA Reporting Forms (see Appendix 2).

Each soil sample was placed in a glass jar and a portion of the headspace vapor was injected into the OVA. A total organic vapor concentration of more than 1000 parts per million (ppm) was measured in a number of these samples. In all of the samples, however, the GC analyses indicated that only one large peak, with a very short retention time, was present. This type of GC pattern is typical of naturally occurring volatile organics (e.g., methane, ethane). Hence, it was concluded that naturally occurring background concentrations of volatile organic compounds are very high, due to the organic nature of the sediments.

Maximum vapor concentrations, as indicated by the OVA, were generally found for soil samples collected between 4 and 8 feet below existing grade. No GC peaks corresponding to fuel oil-related volatile compounds (e.g. benzene, toluene, ethyl benzene) were found at the detection limit of approximately 10 ppm. It should be noted that this detection limit is higher than normal, due to the high concentrations of naturally occurring volatile organics. Other petroleum hydrocarbons, however, were detected in laboratory analyses (see Section 3.1.3). It should be noted that No. 2 fuel oil (diesel) is primarily composed of carbon compounds ranging from C₈ to C₄₀, the majority of which would not be detected by the OVA/GC.

3.1.3 Results of Laboratory Testing

Soil samples analyzed in the laboratory were found to contain between 180 and 8900 ppm of total petroleum hydrocarbon compounds (see Appendix 3).

A number of these samples were also noted to have visual and/or olfactory indications of oil contamination. Table 1 provides a summary of the laboratory results, and the corresponding test boring numbers, soils descriptions, and total head-space organic vapor concentrations.

3.2 GROUND WATER MONITORING

Because of the very limited areal extent of subsurface contamination which was visually observed in the soil samples (see Figure 2), and the numerous restrictions in that area (overhead and underground utilities, building structures, etc.), only one ground water monitoring well was installed.

The ground water monitoring well was installed at the location of

TB-6. It should be noted that this location (TB-6) is the only area at which significant visible oil contamination was observed. The well completion diagram is included in this report as Figure 5. The well screen was placed to intercept the range of anticipated water level fluctuations, the top of the screen being above the anticipated high water level.

On October 12, TAI personnel measured the thickness of the product layer and sampled the groundwater for laboratory analyses. The thickness of the product layer was measured to be 3/8 inches. The groundwater was analyzed for benzene, toluene, ethyl benzene, xylene, and petroleum fuels in groundwater (EPA Method 602, Purgeable Aromatics). The results of these laboratory analyses are presented on the following page with corresponding recommended U.S. EPA Drinking Water Standards or other criteria.

It is the conclusion of the laboratory, based on their gas chromatographic analysis of the ground water sample, that the petroleum hydrocarbons detected in the water samples corresponded to weathered No. 2 fuel oil. The final laboratory report is included in Appendix 4.

Benzene was the only compound detected above current U.S. EPA Drinking Water Standard concentration. These standards apply only to public drinking water supplies (which is not the case at this site) and are used in this context only for comparison purposes. The slightly elevated benzene concentration is believed to be attributed to the No. 2 fuel oil spill and the areal extent of the contaminated ground water should be coincident to that shown on Figure 2. No wells that furnish water for potable purposes are known to be down-gradient or in the vicinity of this site. The elevated concentration is near drinking water standards and the only anticipated fate of the compound is eventual discharge to the Delaware River, which will greatly dilute the contaminated discharging ground water.

LABORATORY GROUND WATER ANALYSES			
COMPOUND	GROUND WATER CONCENTRATION (ppb)	U.S.EPA DRINKING WATER STANDARD/GOAL*	
		MCL	MCLG
Petroleum Fuel in Water	15	--	--
Benzene	20	5	--
Toluene	20	--	2000
Ethylbenzene	80	--	680
Total Xylene	370	--	440

*Please note that U.S. EPA Drinking Water Standards are reported for Benzene as Maximum Contaminant Levels (MCL) and for the remaining compounds as Maximum Contaminant Level Goals (MCLG). MCLG's are provided for those compounds for which federally regulated standards have not been established.

4.0 SUMMARY OF CONCLUSIONS

Since contamination should be vertically bound by floating of the oil on top of the ground water table, the field observations and field/laboratory test results for soil samples collected at the top of the water table were used as a basis for delineating the aerial extent of the No.2 fuel oil contamination from the spill. This aerial extent is illustrated in Figure 2.

Test borings TB-1 and TB-4 penetrated materials thought to be relatively free of contamination. OVA/GC results are near background levels, no visual petroleum contamination was noted from split-spoon samples, and total petroleum hydrocarbons (from laboratory testing) are relatively low.

In TB-3, petroleum contamination was not observed during split spoon sample collection and laboratory testing indicated relatively very low total petroleum hydrocarbon compound concentrations, even though OVA/GC results were relatively high. Hence, we believe that the material penetrated by TB-3 is beyond the area of contamination of the spill. High organic vapor concentrations are probably the result of naturally generated volatiles from the decomposition of vegetation within the fill.

TB-2 is thought to be very near the area of contaminated subsurface materials, as evidenced by visual observation during split-spoon sample collection and moderately high total petroleum hydrocarbon compound concentrations.

TB-6 was located within the limits of the contaminated area, as evidenced by large quantities of oil observed during drilling and sampling and very large petroleum hydrocarbon compound concentrations as determined by the laboratory.

An anomolous laboratory test result was reported for a sample collected from TB-5 at a depth of 8 to 10 feet below existing grade. The total petroleum hydrocarbon compound concentration was determined to be 8900 ppm, the highest concentration determined during this investigation. We believe this analysis is due to subsurface conditions unrelated to the No.2 fuel oil spill, for the following reasons:

- (1) TB-5 is the farthest boring from the spill area (over 200'), and is located in another portion of the facility;
- (2) the intervening borings (TB-4 and TB-3) are relatively clean;
- (3) the sample from TB-5 did not contain visible evidence of oil contamination; and
- (4) it is expected that shallow ground water flow is directly from the spill location to the river, and would be unlikely to flow in the direction of TB-5 (to the west).

We would expect that, if the elevated concentration discovered in the sample from TB-5 was associated with the No. 2 fuel oil spill, the samples collected from TB-3 and TB-4 would have also exhibited elevated concentrations. This is based on the fact that apparent subsurface hydrological connections exist between TB-6, TB-3, TB-4, and TB-5 (see Figure 4 and note potential high permeability afforded by subsurface materials between borings).

For the aforementioned reasons, the laboratory result for soil from TB-5 was not considered in the development of the contamination delineation shown on Figure 2. The source(s) of the elevated concentrations determined from the sample of TB-5 is unknown at this time.

As discussed in Section 3.2 of this report, a ground water monitoring well was constructed at the location of TB-6. Ground

water samples were collected and analyzed for petroleum fuel in water and for BTEX (benzene, toluene, ethylbenzene, and xylene). The results of the laboratory analyses are shown on the table on Page 7. Benzene was the only compound detected (at 20 ug/L) above the current U.S. EPA Drinking Water Standard concentration. As discussed previously, the benzene is probably associated with the fuel oil spill, but is present at low concentrations, in a limited area. The slightly elevated concentration, the estimated aerial extent of the elevated concentration, and the fate of the contaminant have been discussed in more detail in Section 3.2, Page 8 of this report.

5.0 RECOMMENDATIONS

Using a measured product thickness of 3/8 inches (as observed from TB-6), the delineated area as shown on Figure 2, and a conservative porosity estimate of 50%, it is estimated that approximately 600 to 700 gallons of product may be present in the subsurface materials at the site. This quantity estimate is based on assumptions derived from the data gathered during this investigation and should be considered conservative. The permeability of the subsurface materials was estimated to be approximately 10^{-4} centimeters per second. This approximation was based on the grain-size of the sediments and ground water recovery observations. The amount which may be recovered cannot be quantified at this time. However, due to the low permeability of the deposits, and the tendency for the oil to adsorb onto the fine-grained subsurface materials, the quantity of fuel oil that can be recovered by pumping can be expected to be considerable less than the total amount spill, even using aggressive recovery techniques.

Two remedial alternatives are possible: (1) recover product from the subsurface by pumping, and (2) continue, for the long term,

recovering the product with the existing absorbant booms. The latter method would not recover dissolved components of the fuel oil. Due to restrictions imposed by overhead and underground utilities, and by existing plant structures (buildings, piping, etc.), it is believed that remediation of soils contamination via excavation is impractical at this site.

5.1 FIRST ALTERNATIVE

From observations made during the development and ground water sampling of TB-6, infiltration into the well from the surrounding subsurface materials is relatively slow, with full recovery of that well requiring approximately 30 minutes. If this alternative for remediation is selected, a pump, automatically capable of intermittent pumping, set to a depth at or below static water levels (considering natural ground water fluctuations), should be the most efficient system.

5.2 SECOND ALTERNATIVE

The second remedial option, consisting of continued recovery of oil with absorbant booms already deployed in the cove, is a viable method of recovering the oil at this site. We recommend that the product layer thickness, as measured from TB-6, be monitored by Scott Paper Company personnel on a set frequency (such as once every month). A product layer thickness of zero inches for at least three consecutive readings would indicate that the source of the oily contamination has been depleted. These observations could support observations of diminished contamination within the cove and the decision to retire the absorbant booms. If this alternative is selected as the sole remediation method, its duration should be lengthy. This method will not recover dissolved components of the oil, but these compounds are not present at significant concentrations, and would be expected to

diminish over time due to natural biodegradation and dilution with recharge. Periodic ground water sampling and analyses may also be performed to confirm decreasing dissolved contaminant concentration levels.

oOo

TABLE 1
SOIL SAMPLE LABORATORY ANALYSES.

SAMPLE NUMBER	HOLE NUMBER	DEPTH FROM EXISTING SURFACE (ft)	SUBSURFACE MATERIAL DESCRIPTION	MAXIMUM FIELD OVA READING (ppm)	LABORATORY TOTAL PETROLEUM HYDROCARBON COMPOUNDS (ppm)
B-1D	TB-1	6-7	Pea to 3/4" Gravel, Rndd, V Wet; Wood Frags on Top	610	430
B-2E	TB-2	8-10	Silt, V Dk Gr to Gr; Some Organic or Root Matted Lamins; Wood @ Bottom.	> 1000	750
B-3E	TB-3	8-10	V Wet Silt, V Dk Gr to Gr, Fairly Clean, Continuous	> 1000	180
B-4C	TB-4	10-12	Very little soil recovered; Much wood recovered; could not distinguish in-place soil from cave material; I'void @ Bot.	610	570
B-5E	TB-5	8-10	Silt, V Dk Gr w/ Abundt wood & Oyster Shell Frags. Silt, Gr @ bottom 2".	840	8900
B-6E	TB-6	8-10	Fill; Gravel and Silt Matrix. Visual Petroleum Contamination.	> 1000	3900

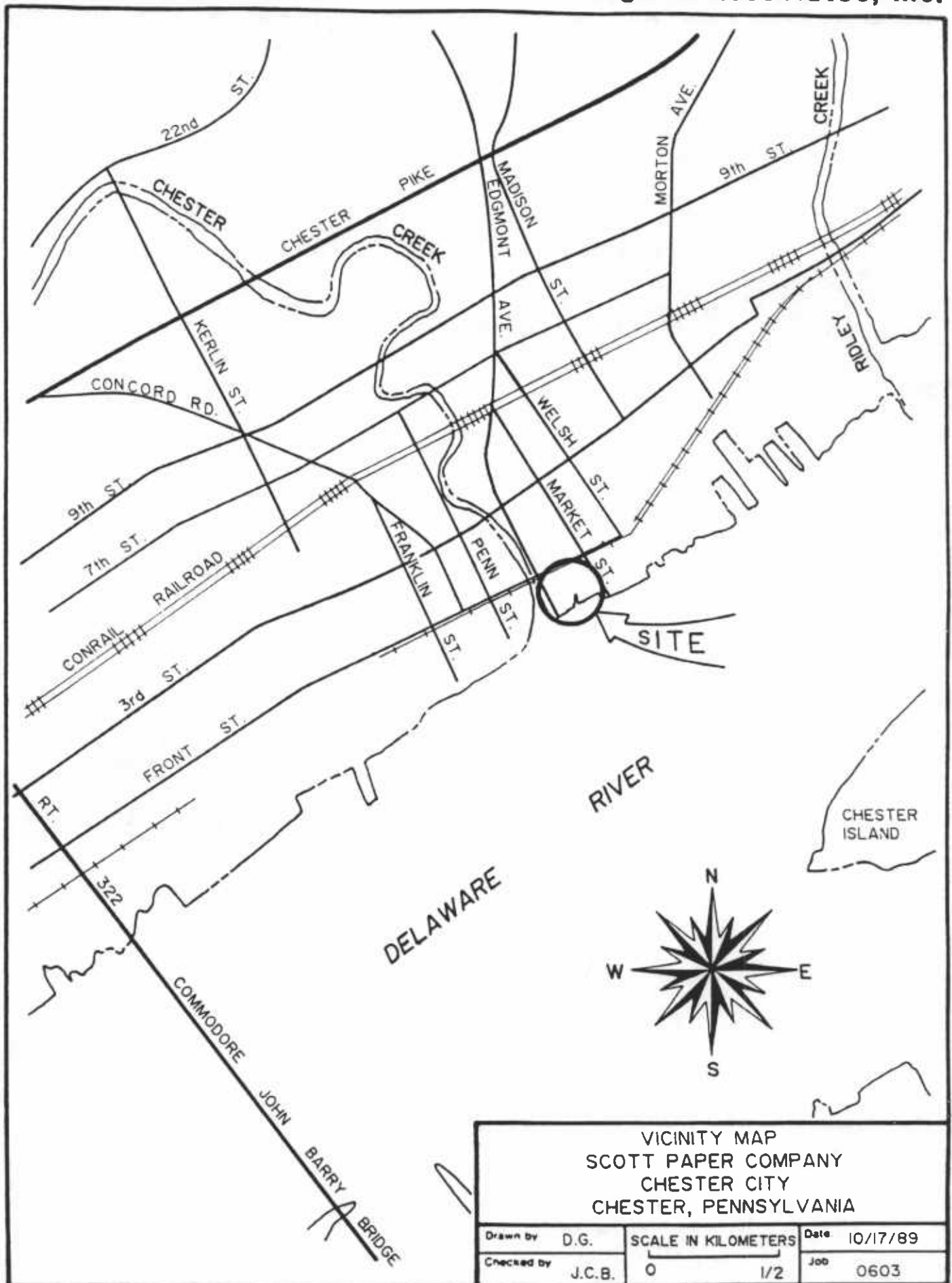


FIGURE 1

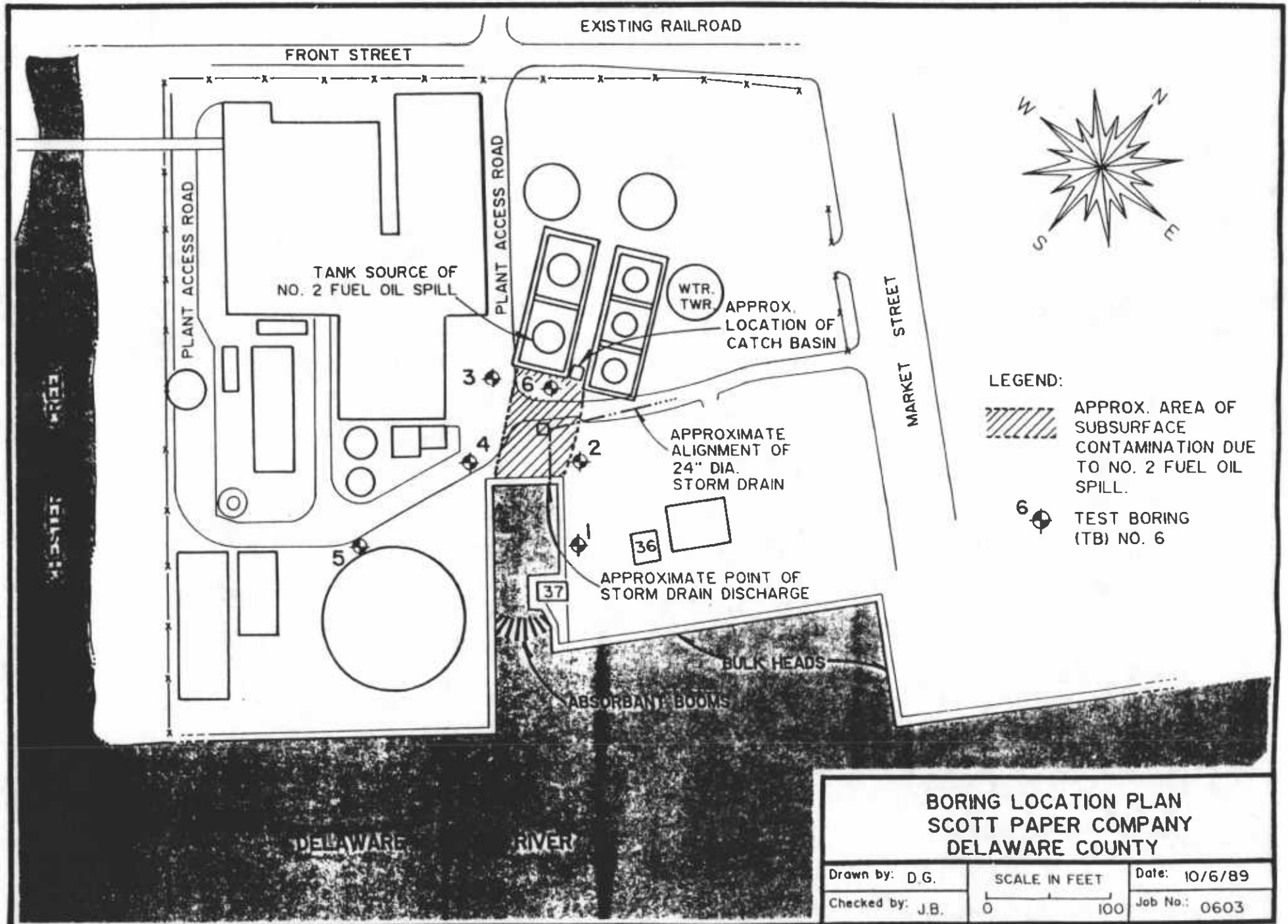


FIGURE 2

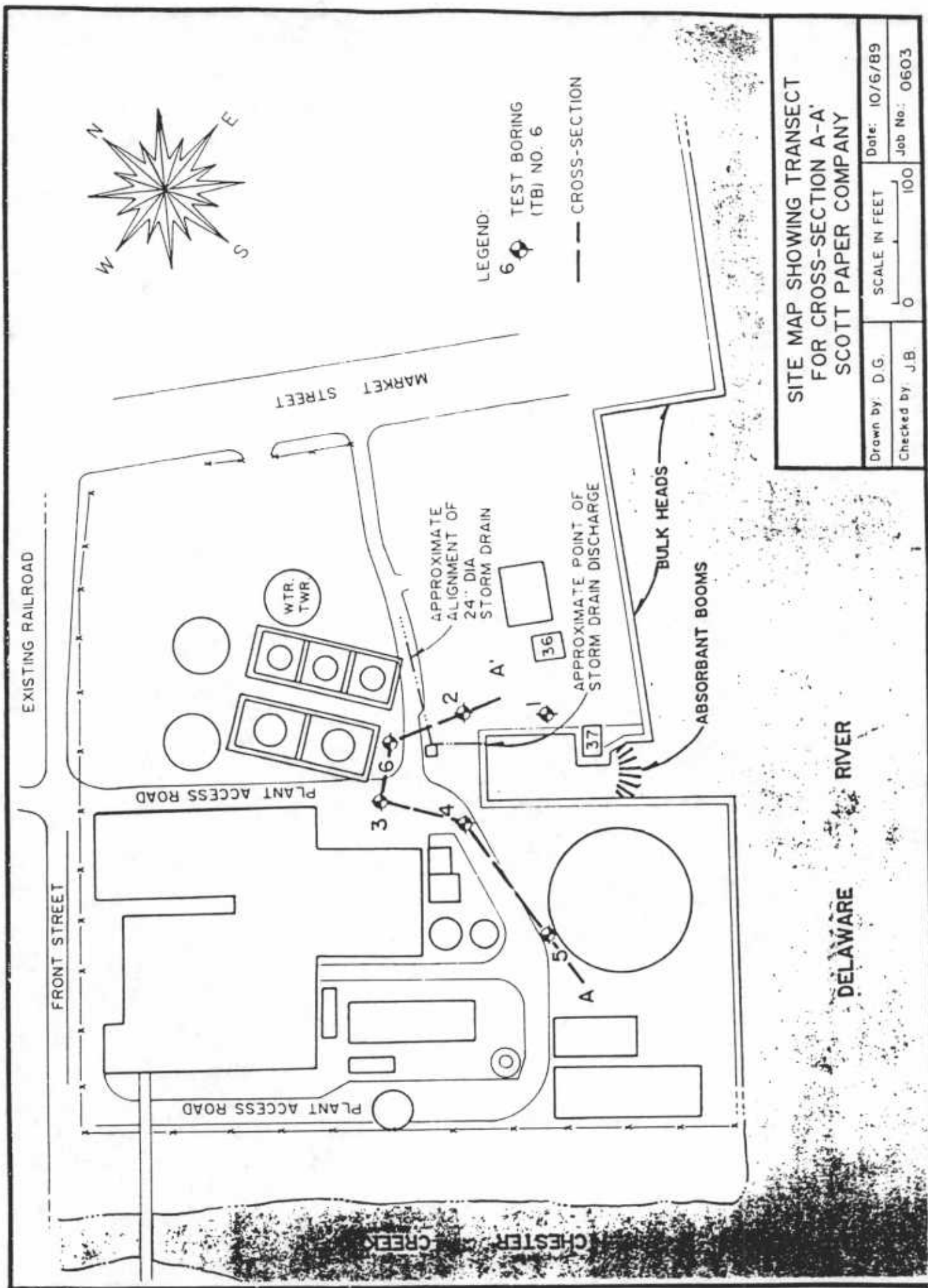
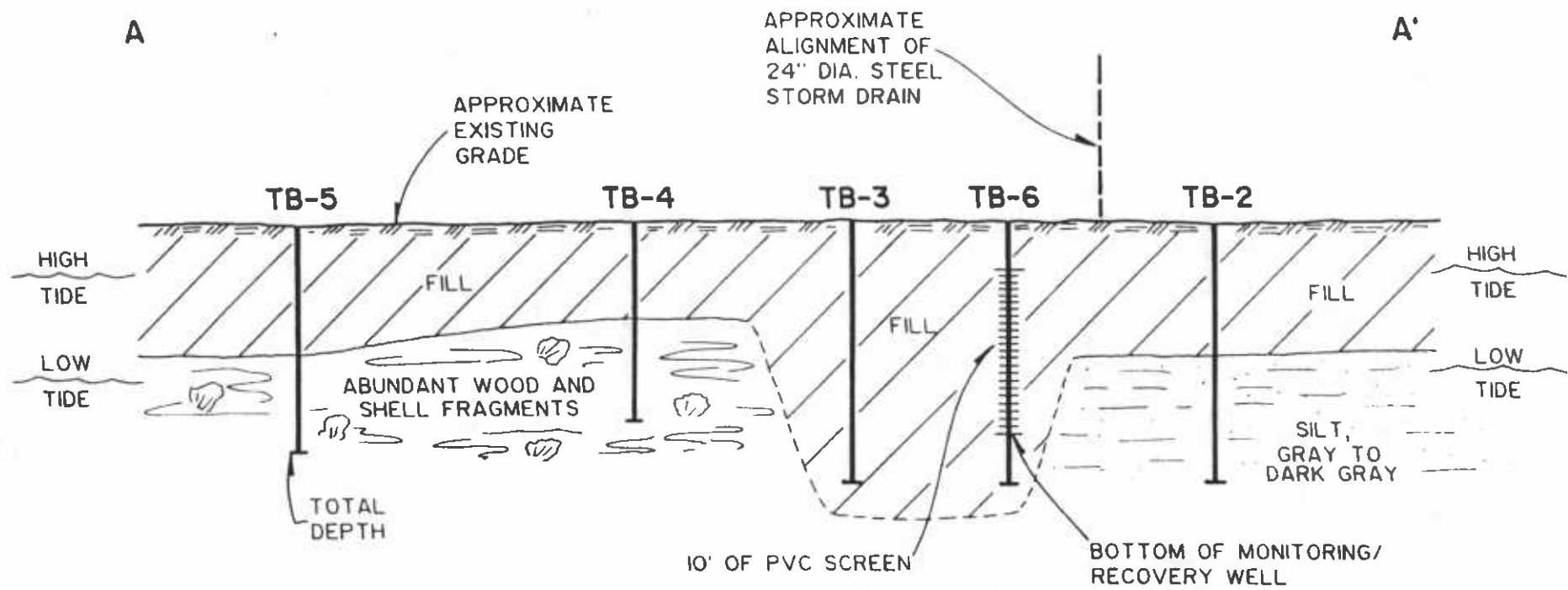


FIGURE 3



LEGEND:

TB-5 = TEST BORING NO. 5

VERTICAL SCALE: 1" = 10'
HORIZONTAL SCALE: 1" = 50'

SCHEMATIC CROSS-SECTION A-A'
SCOTT PAPER COMPANY
DELAWARE COUNTY, PENNSYLVANIA

Drawn by: D.G.

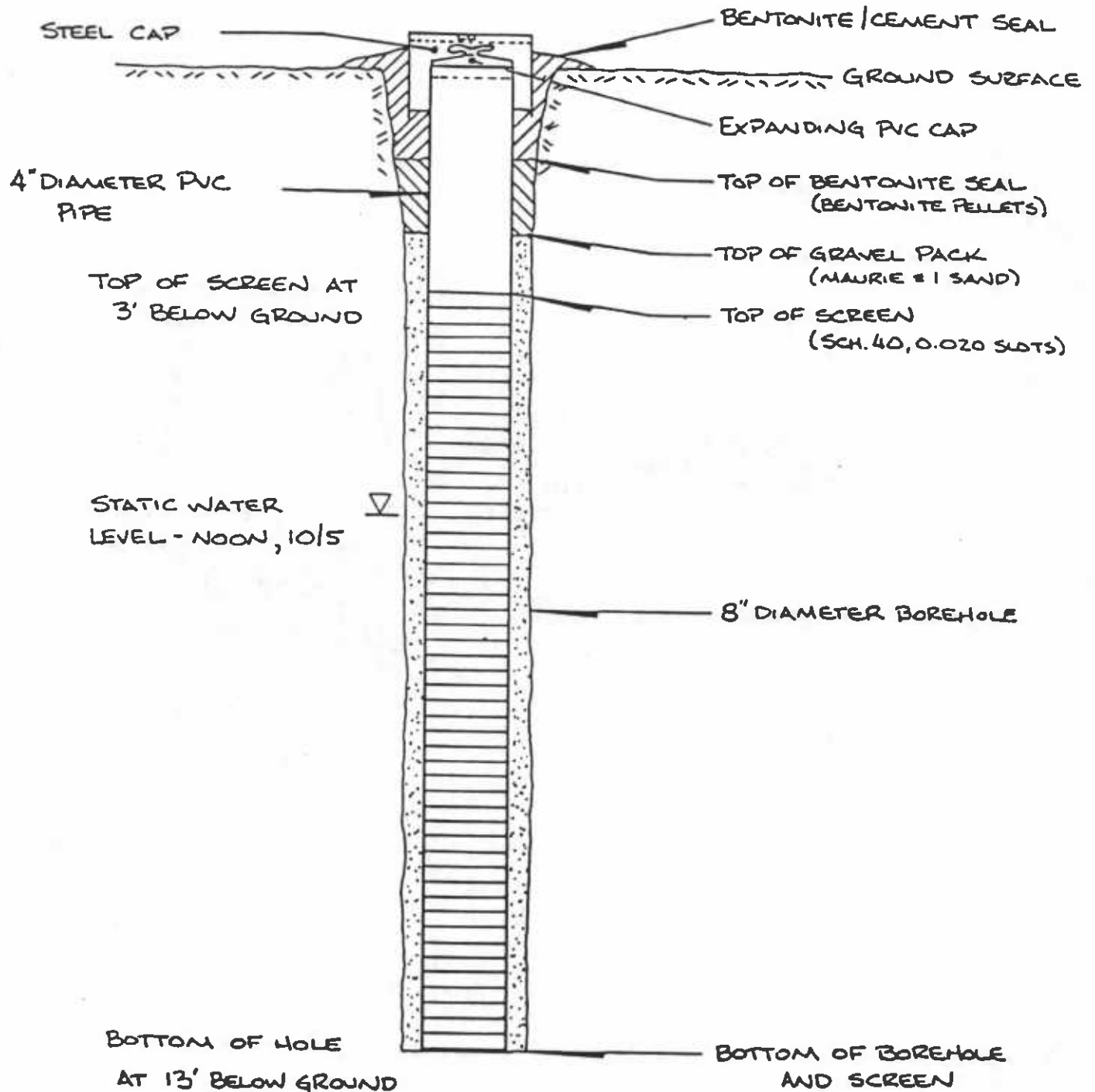
Date: 10/18/89

Checked by: J.B.

Job No: 0603

FIGURE 4

FIGURE 5
WELL COMPLETION DIAGRAM
BOREHOLE #6



VERTICAL SCALE : 1" = 2'

APPENDIX 1
TEST BORING LOGS

Surface Elev. (Ft./MSL):

After Drilling

Date SWL Measured: _____

NOTES:

Surface Elev. (Ft./MSL):

After Drilling

Date SWL Measured: 10/3/89

NOTES :

Surface Elev. (Ft/MSL): _____

After Drilling

Date SWL Measured: 10/3/89, _____

NOTES:

Borehole Number: 4
Surface Elev. (Ft/MSL):

Borehole Diam. 8 in., From 0 To 12
 in., From To
 Total Depth: 12
 Depth to SWL: (ft)
 Date SWL Measured:

NOTES:

Borehole Number: 5
Surface Elev. (Ft/MSL):

Drilling Meth: Auger
Date Drilled: 10/3/89
Drilled By: Test Well
Logged By: JCB
County: Delaware
Township or Munic. _____
Chester
State: Pennsylvania
After Drilling

Borehole Diam. 8 in., From 0 To 14
 in., From To
 Total Depth: 14
 Depth to SWL: 6 (ft)
 Date SWL Measured: 10/3/89,

NOTES:

Borehole Number: 6
Surface Elev. (Ft./MSL): _____

Drilling Meth: Auger
Date Drilled: 10/3/89
Drilled By: Test Well
Logged By: JCB
County: Delaware
Township or Munic. _____
Chester
State: Pennsylvania
After Drilling

Date SWL Measured: 10/3/89

NOTES:

APPENDIX 2
OVA REPORT FORMS

SITE LOCATION: Chester, Pennsylvania

WELL/BORING NUMBER:

BACKGROUND: 4 ppm

TEMPERATURE: 75 °F

DATE: 10/3/89

COMPLETED BY: JD

GC STANDARD	ELUTION TIME	COLUMN
* PCE	2:52	T-12
*		
*		

SAMPLE NUMBER	DEPTH INTERVAL	LITHOLOGY	OVA READINGS (ppm)			COMMENTS ON GC ANALYSIS
			BREATHING ZONE	BOREHOLE	HEADSPACE SAMPLE	
B-1A	0-2				600	:06 120 ppm
B-1B	2-4				220	:12 22 ppm
B-1C	4-6				100	:12 12 ppm
B-1D	6-7				610	:12 225 ppm
B-1E	8-10				> 1000	:12 530 ppm
B-2A	0-2				> 1000	:08 300 ppm
B-2B	2-4				> 1000	:06 520 ppm
B-2C	4-6				100	:08 10 ppm
B-2D	6-8				480	:08 100 ppm
B-2E	8-10				> 1000	:06 540 ppm
B-2F	10-12				> 1000	:08 300 ppm

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SITE LOCATION: Chester, Pennsylvania

WELL/BORING NUMBER:

BACKGROUND: 4 ppm
TEMPERATURE: 75 °F

DATE: 10/3/89

COMPLETED BY: JD

GC STANDARD	ELUTION TIME	COLUMN
* PCE	2:52	T-12
*		
*		

SAMPLE NUMBER	DEPTH INTERVAL	LITHOLOGY	OVA READINGS (ppm)			COMMENTS ON GC ANALYSIS
			BREATHING ZONE	BOREHOLE	HEADSPACE SAMPLE	
B-2G	12-14				> 1000	:06 610 ppm
B-2H	14-16				> 1000	:06 680 ppm
B-3A	0-2				30 (Dial)	:08 2 ppm
B-3B	2-4				80	:08 22 ppm
B-3C	4-6				360	:08 80 ppm
B-3D	6-8				420	:08 140 ppm
B-3E	8-10				> 1000	:08 200 ppm
B-3F	10-12				> 1000	:08 360 ppm
B-3G	12-14				> 1000	:08 220 ppm
B-3H	14-16				940	:06 240 ppm

TRIEGEL & ASSOCIATES

SITE LOCATION: Chester, Pennsylvania

WELL/BORING NUMBER:

BACKGROUND: 4 ppm
TEMPERATURE: 75 °F

DATE: 10/3/89

COMPLETED BY: JD

GC STANDARD	ELUTION TIME	COLUMN
* PCE	2:52	T-12
* _____	_____	_____
* _____	_____	_____

OVA READINGS (ppm)						
SAMPLE NUMBER	DEPTH INTERVAL	LITHOLOGY	BREATHING ZONE	BOREHOLE	HEADSPACE SAMPLE	COMMENTS ON GC ANALYSIS
B-4A	4-6				0.6	None
B-4B	6-8				11	:06 2 ppm
B-4C	10-12				610	:06 180 ppm
B-5A	0-2				0.8	None
B-5B	2-4				200	:08 15 ppm
B-5C	4-4.3				260	:06 60 ppm
B-5D	6-8	Jar Not Tightly Sealed			6	None
B-5E	8-10				840	:06 240 ppm
B-5F	10-12				160	:06 30 ppm
B-5G	12-14				340	:06 90 ppm

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SITE LOCATION: Chester, Pennsylvania

WELL/BORING NUMBER:

BACKGROUND: 4 ppm
TEMPERATURE: 75 °F

DATE: 10/3/89

COMPLETED BY: JD

GC STANDARD	ELUTION TIME	COLUMN
* PCE	2:52	T-12
*		
*		

SAMPLE NUMBER	DEPTH INTERVAL	LITHOLOGY	OVA READINGS (ppm)			COMMENTS ON GC ANALYSIS
			BREATHING ZONE	BOREHOLE	HEADSPACE SAMPLE	
B-6A	0-2				56	:06 12 ppm
B-6B	2-4				290	:08 70 ppm
B-6C	4-6				> 1000	:06 340 ppm
B-6D	6-8				> 1000	:06 230 ppm
B-6E	8-10				> 1000	:06 > 1000 ppm
B-6F	10-12				> 1000	:06 580 ppm
B-6G	12-14				> 1000	:08 > 1000 ppm

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